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Using Chip Technology To Detect And Prevent Diseases

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Semiconductor economies of scale begin filtering into the medical market.

APRIL 11TH, 2016 - BY: **MICHAEL WATTS (HTTP://SEMIENGINEERING.COM/AUTHOR/MICHAEL-WATTS/)**

The overlap between semiconductor technology and medicine is growing, creating the same kinds of economies of scale that have fueled the semiconductor industry for the past five decades.

While technology has long held a place in the medical world, the idea that chips can save lives and improve health is a relatively new concept. That effort is gaining steam, too, as more capabilities are added onto silicon and more parts of the chip ecosystem are included.

One such example comes from Microfluidic ChipShop, a German chipmaker specializing in microfluidics, that has developed a medical assay system. Holger Becker, CSO at Microfluidic ChipShop, showed off the results of a Gates Foundation project to develop a hands free “modular micro fluidic cartridge based universal diagnostic system for global health applications” that can meet aggressive cost targets of less than $5 a test and $10,000 for the instrument.

The approach, which was presented by Becker at the recent Photonics West conference, starts with an injection-molded modular cartridge using re-agents in blister packs, chemicals, N-way valves, mixing, lysing, and detection elements for optical detection and electrical detection. The cartridge can have custom plumbing and sequencing to do a comprehensive range of diagnoses, including molecular DNA tests for tuberculosis, immuno-assay for HIV, antibody, and chemical tests. The instrument has interfaces to all the moving parts and the detectors to run the complete test and analysis. The technician loads a 20 to 200 micro-liter sample and everything else is automatic.

"We have a prototype instrument and and examples for all three classes of test," Holger said. "The most complex is a hands-free, 40-step PCR process that is used to test for TB." The company is working with the Gates foundation to find a path to completion and distribution of its solution.

"This is really an evolution of our current business, supplying custom and standard devices with design and applications support," he said. Microfluidic ChipShop was founded in 2002, and is growing at 20% a year. It currently has 80 employees.

Robert Walker, CEO of RayVio, talked about elimination of water or surface-borne infection using deep UV LED light sources.

Water-borne infections are the largest single naturally occurring cause of death on the planet. In the United States, secondary infections resulting from hospital stays kill more people than guns or cars. So a low-cost technique for disinfection that does not trigger the evolution of resistance would have a huge impact.

Deep UV has been used for many years destroy the DNA of the infectious species and disinfect water using industrial scale mercury lamps. These lamps are contamination hazard, are high cost, require high voltages, and are not an option for general purpose disinfections.

"We are developing demonstration applications that highlight the potential for our high power AlGaN deep UV diodes," said Robert Walker CEO at RayVio. "An LED, in a small, low-cost package that switches on instantaneously can be a Point Of Use (POU) disinfection tool for surfaces or for water."

RayVio is a venture-funded startup that has "raised $13 million to date and will be announcing a new larger round in the near future. Its technical challenge is that AlGaN is much more defect-sensitive than GaN, and so far high-power deep-UV devices have been grown on native substrates. RayVio uses an exclusive license from Boston University for AlGaN that makes the material properties defect insensitive.

A patent search reveals a U.S. patent application owned by Boston University with RayVio CTO as co-inventor: "A method of growing an AlGaN semiconductor material utilizes an excess of Ga above the stoichiometric amount typically used. The excess Ga results in the formation of band structure potential fluctuations that improve the efficiency of radiative recombination and increase light generation of optoelectronic devices."

RayVio did not confirm whether it utilizes this technology in their devices. Based on the patent, it appears that by modifying the growth conditions the company can improve device quantum efficiency. Walker showed results for a 40 mw LED grown on sapphire being manufactured in the Bay Area. He said the recipe for high-power LED typically includes thin devices for light extraction, and flip chip for good heat extraction.

"A single, battery-driven 40 mw LED could POU (point of use) decontaminate a relatively clean household tap," Walker said.

Still, one challenge is how to provide the testing support so the user knows they have used enough UV exposure to take care of the local threat. Walker acknowledged that "on-site testing needs to be developed to support field applications."

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